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SAINT MATTHEW ISLAND REINDEER RANGE STUDY

SPECIAL SCIENTIFIC REPORT: WILDLIFE No. 43

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United States Department of the Interior, Fred A. Seaton, Secretary
U.S. Fish and Wildlife Service, Arnie J. Suomela, Commissioner

SAINT MATTHEW ISLAND REINDEER-RANGE STUDY

by

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Bureau of Sport Fisheries and Wildlife

Federal Aid to Wildlife Restoration Project, Alaska W-3-R

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ABSTRACT

A field study of reindeer-range relationships on St. Matthew Island in the Bering Sea was made during the summer of 1957. Population counts showed that the reindeer herd had increased from the original stocking of 29 animals in 1944, to number approximately 1,350 animals in 1957, an average annual rate of 34 per cent. Range studies in conjunction with the establishment of permanent range enclosures and transects showed indications of serious over-utilization by reindeer of lichens and willows on the winter range.

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INTRODUCTION

The occurrence of an unharvested and rapidly increasing reindeer herd on St. Matthew Island in the Bering Sea Wildlife Refuge offered the opportunity to initiate studies of reindeer-range relationships to take advantage of this unique situation. It was felt that the knowledge of the population dynamics and range ecology of this isolated reindeer herd, with a known history and free of human interference, would be of considerable value in understanding comparable range-association problems of the caribou herds on the mainland of Alaska. The study was designed to enable an insight into both the population dynamics of the reindeer herd and its range relationships. The work was financed with Federal Aid to Wildlife Restoration Funds under Alaska Pittman-Robertson Project Number W-3-R.

Field work was done during the period July 15 - August 9, 1957 by the author and field assistant James Whisenhant. Transportation of personnel and equipment, both to and from St. Matthew Island, was accomplished by the Coast Guard Cutter "Wachusett". A brief stop at Hall Island was made on August 9, after departure from St. Matthew Island.

During this study there was opportunity to collect information relative to other animal populations on, or adjacent to the island. Lists of mammals, birds and fishes seen, or known to occur, on St. Matthew Island are included in the Appendix with estimates of numbers present. A brief summary of suggestions to aid in future temporary or permanent habitation of the island is included in the Appendix.

Most of the plants collected were identified by Dr. Herbert C. Hanson of Catholic University of America, with cooperation from Rev. M. Duman on the sedges and rushes, W.C. Steere on the mosses and J.R. Swallen on one species of Poa. Dr. Hanson also supplied invaluable assistance in the interpretation of plant relationships in the ecology of the reindeer range. Lichens were identified by Hildur Krog of the Museum of the Royal Norwegian Society of Sciences. Lists of plants collected appear in Appendix Table 8.

ISLAND TOPOGRAPHY AND WEATHER

St. Matthew Island (N 60° 30' by W 172° 30') is located in the Bering Sea Wildlife Refuge approximately 200 miles south of St. Lawrence Island and 170 miles west of Nunivak Island. It is about 32 miles long by 3½ wide and comprises 128 square miles. The topography of the island is characterized by a series of north-south ridges, with intervening low valleys. The ridges are about a thousand feet high, are in most cases eroded to smooth contours and are of volcanic origin. The precipitous basalt cliffs, formed by the cutting action of the sea on the mountains, indicate that the basic relief of the island was formed by an extensive complex of lava flows. The

irregular character of the island is broken in two places on the southern portion where extensive dry flats, only a few feet above sea level, extend across the island (Figs. 13 and 14). Earth disturbances adjacent to the cliffs, mentioned by Hanna (1920), are apparently the result of land slippage where concentrations of a mineral, similar to bentonite, occur in the soil and decomposing volcanic rock. This mineral has a marked affinity for water with which it forms a greasy gumbo-like texture, very conducive to mass slippage of the earth.

There are several fresh and brackish water lakes on the island, many of which have been formed by gravel bars built by wave action. Storm tides bring salt water into some of the lakes. Residual snow banks, ground water and precipitation feed the numerous small streams which drain the valleys and empty into the lakes.

The climate of St. Matthew Island is characterized by extreme wind velocities, a moderate temperature for such a high latitude, considerable summer fog and an annual precipitation of 15 inches. A weather summary kept by the U.S. Army from September 1943 through August 1944 on St. Matthew Island, is presented in Appendix Table 1.

HISTORY OF THE REINDEER HERD

The existing reindeer herd on St. Matthew Island is the result of the release of 24 female and 5 male reindeer on August 20, 1944, by the U.S. Coast Guard (Beals, 1944). The animals, which were all two-year-olds, were obtained from the Nunivak Island herd near Nash Harbor and were transported by the Coast Guard Cutter "Clover". The objective of the release was to establish a small herd as an emergency food supply during World War II. A Coast Guard loran station and an Army weather station were maintained on the island during the war years, but both were abandoned before the herd was of harvestable size. Shooting of the newly established animals by the military personnel was not permitted. The island has been uninhabited since then and no harvest of reindeer has taken place.

REINDEER POPULATION COUNTS

The total count of the entire reindeer herd was obtained at a time when the main body of the herd was located on the narrow part of the island south of Big Lake (See Fig. 1). Four consecutive days were spent in making this count and complete coverage of the island was obtained from southeast to northwest. During 1957 a total of 1,226 reindeer were counted, with no known duplication existing. While making the counts at the north end of the island some animals were missed due to impaired visibility by fog. Large bulls, which were scattered throughout this area at the time, probably constituted the greater portion of the animals missed. This is also indicated by the disproportionate sex ratio among the older animals in the raw

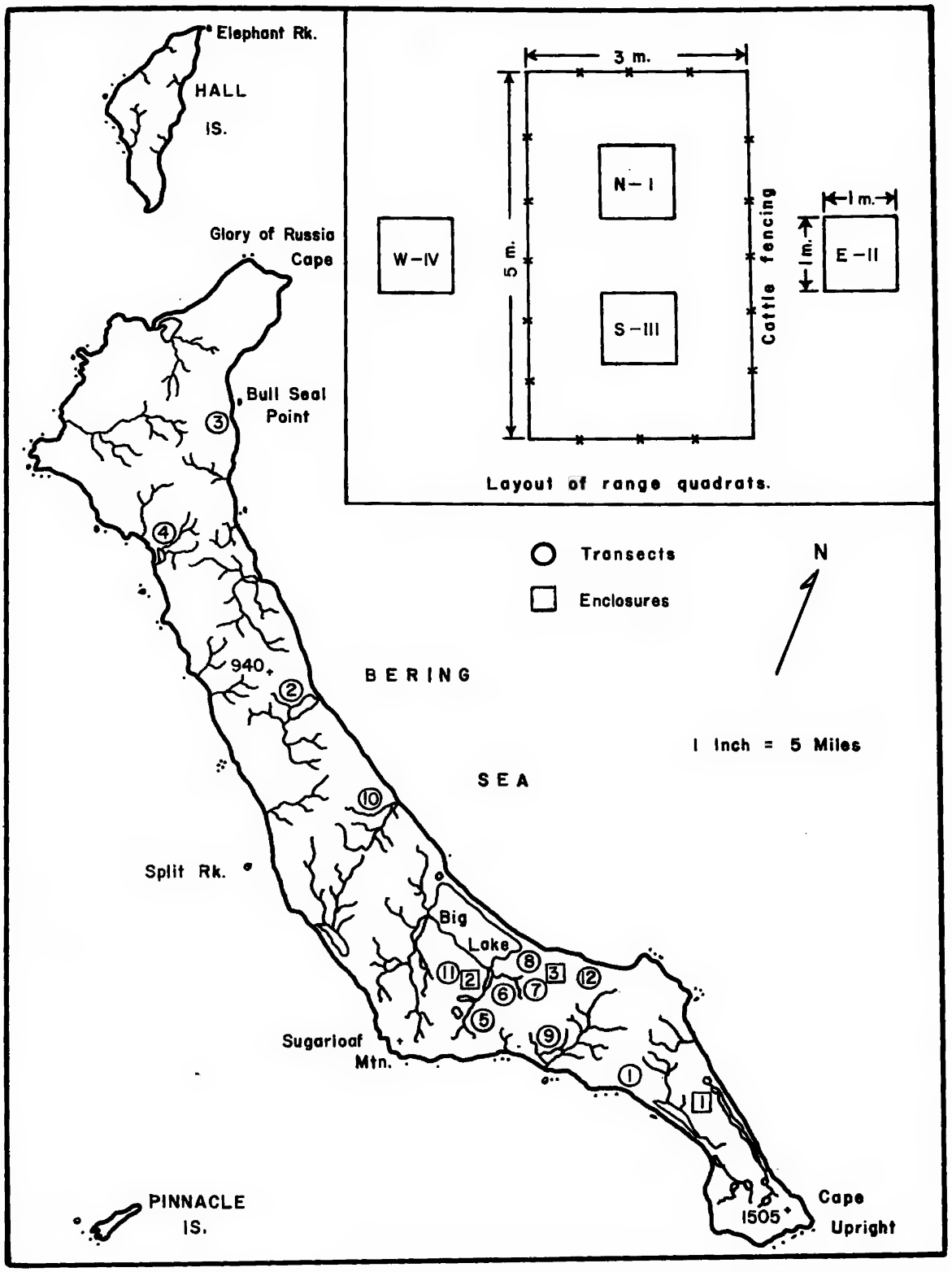

Figure 1. St. Matthew Island, Alaska, showing the location of line transects and range enclosure stations established in 1957. Inset shows the layout of the meter-square range study plots at each station.

counts. By comparison of the composition counts with the assumed herd composition, it seems likely that approximately ten per cent of the herd was not counted (See Table 1 and 2). Adding the ten per cent missed to the total animals counted, gives a rounded population figure of 1,350. This represents an average yearly rate of increase of 34 per cent since their release in 1944. Actually, it is probable that the rate of increase was higher than this during the first few years, due to the large proportion of producing females in the initial stock and the absence of non-producing young stock. Among reindeer, yearling cows breed and have fawns when they are two years old, while caribou are a year later in this respect. Also, female reindeer on good range frequently are bred in their first year and have their first fawns when they are one year old (Chase, letter, 1957). As sex and age ratios adjusted to more natural conditions, the rate of increase quite likely stabilized at a lower figure. The assumed population growth of the herd in the thirteen years since the original stocking is depicted graphically by the growth curves in Figure 2. Rausch's minimum estimate of 400 to 500 reindeer in 1954 and Rhode's estimate of 700 to 800 in 1955, add credence to the assumption of the herd's rate of growth. Scandinavian figures quoted by Hadwen and Palmer (1922) show average herd increase for managed reindeer herdsto be about 25 per cent. The growth of the reindeer industry in Alaska in the twenty year period from 1902 to 1921 showed an annual net increase of 27 per cent, or an annual gross increase of 33.3 per cent, if total harvested animals are considered (Hadwen and Palmer, 1922). The reindeer herd on St. Paul Island, also in the Bering Sea, showed an average annual rate of increase of 19 per cent during its build-up period, however, when examined on a yearly basis, this rate fluctuated widely from negative values in two years to as much as 42 per cent four years before the peak was reached (Scheffer, 1951).

Sex and age composition counts were made whenever the opportunity for close observations of reindeer existed. Binoculars and a 20-30 power spotting scope were used to aid in the differentiation of sex and age groups. Segregation of fawns from adults was possible for 910 animals. Yearling segregation, which was more difficult and required closer observation, was obtained for 218 reindeer. Three hundred large bulls were tallied out of the total count of 1,226. During the period of the study the cows and young stock, which composed the main body of the herd, remained in the area northwest of the Cape Upright flats and southeast of peak 940 (Fig. 1), while the large bulls were scattered over the northwest and southeast extremities of the island. A summarization of the composition counts is shown in Table 1 and the assumed herd composition is shown in Table 2.

The fawn ratio of 26 per cent of the total adults, while indicative of a continuing population increase, is nevertheless, below the indicated level of previous years. This may mean that the herd has already exceeded the point of inflection on the sigmoid growth curve

TABLE 1 REINDEER COMPOSITION COUNTS, ST. MATTHEW ISLAND

July 15 - August 9, 1957

Object of Count	Total Animals	Fawns		Bulls 2 yrs.		Cows	Yearlings	
		No.	% of Total	No.	% of Total		No.	% of Total
Fawn segregation	910	267	29	none		not segregated		
Yearling segregation	218	75	34	none		99	45	21
Total count	1,226			300	24			

TABLE 2 ASSUMED HERD COMPOSITION, ST. MATTHEW ISLAND - 1957

(From sample counts, Table 1)

Total Herd	Fawns			Yearlings			Cows Over Yearling Age	Bulls Over Yearling Age
	No.	% of Adults	% of Herd	No.	% of Adults	% of Herd		
1350	280	26	21	190	22	14	470	410

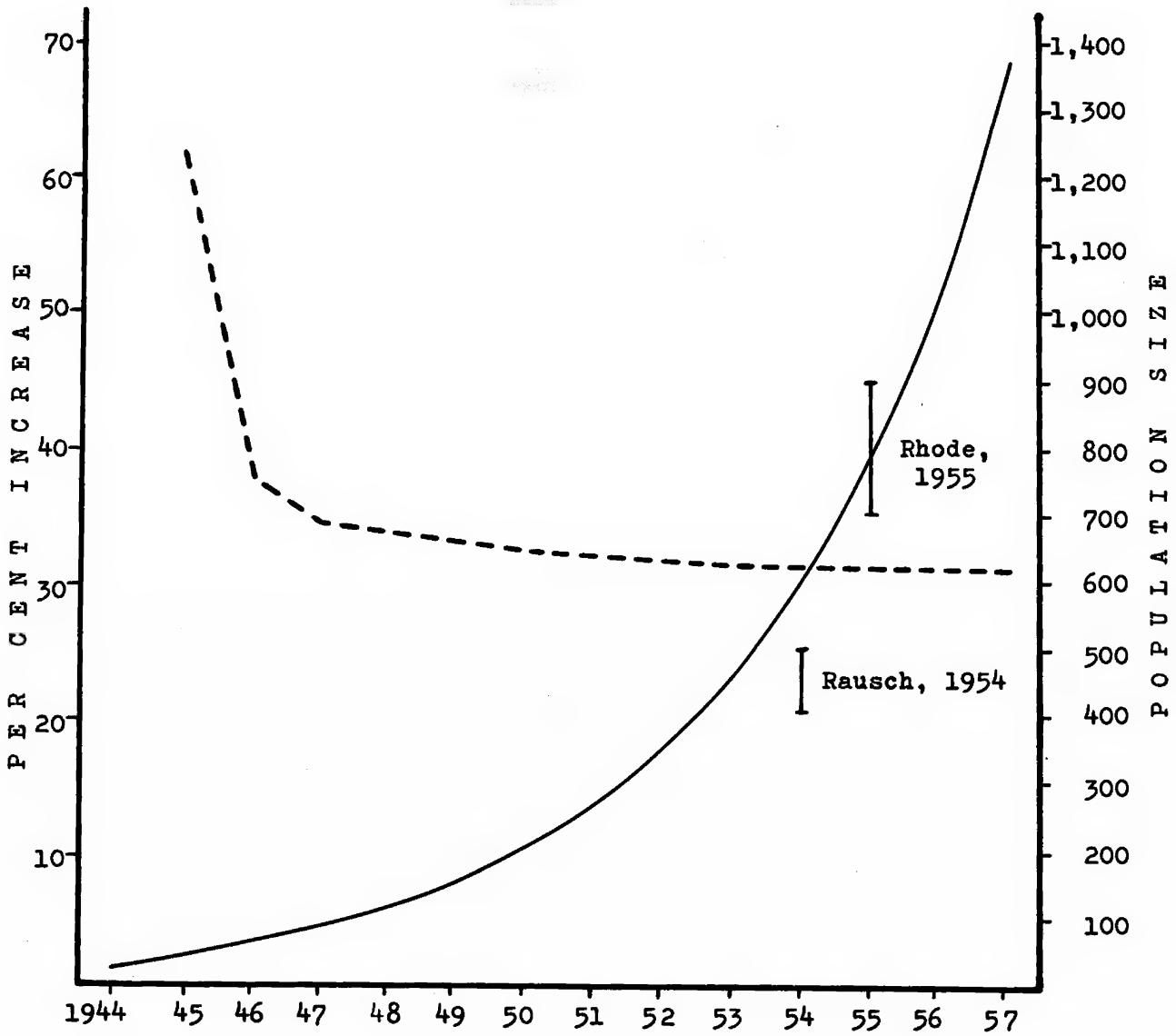

Figure 2. Assumed population growth of the St. Matthew Island reindeer herd, 1944 through 1957. The broken line curve shows the instantaneous percentage rate of population growth of the reindeer since their introduction in 1944. The cumulative population growth is shown by the solid line curve for the same period. Population estimates by Rausch in 1954 and Rhode in 1955 are shown in relationship to the growth curve.

(Fig. 2), and has entered the decelerating phase of population growth. The 34 per cent fawn ratio in the smaller sample counted (218), is probably biased. This count is the sum of many segregation counts of small bands which are predominantly cows accompanied by fawns and some yearlings. Barren cows and the majority of the yearlings usually remained in the larger groups (100 plus).

NATURAL MORTALITY

The skeletons or other remains of 31 reindeer were found during the course of the study. Whenever possible, these were sexed by examination of the antlers and pelvis and aged by tooth appearance. No remains of reindeer were found northwest of peak 940, which reflects the concentration of winter activity on the southeast portion of the island. This sample of natural mortality is presented in Table 3. It is apparent, upon examination of these data, that the greater portion of animals represented fall in the older age groups and reindeer over eight years of age make up the largest group. This is partially explained by the less apparent nature of the remains of very young animals and the ease with which they are scattered by foxes. Bearing this in mind, the predominance of old animals in the mortality is logical under a very low mortality rate, which is expected in view of the rate of increase. At first appearance this sample appears exceptionally small in view of the total population present. However, old animals which are present in greatest numbers in the kill represent a very small portion of the total population; probably less than 10 per cent. The low ratio of females to males represented in the sample is quite likely due to the less apparent nature of female remains. The large bleached antlers of bulls were frequently all that could be seen of a skeleton above the surrounding vegetation, while the smaller antlers of cows were not as readily seen and are more subject to destruction by foxes, mice and shattering by frost action. The large number of antlered bulls represented in the sample indicates that these animals died in the early winter, probably shortly after the rut and prior to the shedding of antlers.

The legs and feet of newborn fawns were found at two different arctic fox dens, however, there was no evidence to indicate the cause of death. Foxes were very effective in locating carcasses of reindeer which had been killed for examination and evidence of their presence at old kills was very common.

Six reindeer are known to have died after their antlers had become entangled in copper wire at the abandoned Coast Guard station (Fig. 3). One reindeer was observed to be lame due to a piece of wire wound around its leg at the knee joint. A shed antler, with about ten pounds of wire entangled on it, was found four miles from the Coast Guard station.

TABLE 3. NATURAL MORTALITY AMONG THE ST. MATTHEW IS. REINDEER HERD

(From skeletons & remains found July 15 - Aug. 9, 1957)

Age (yrs.)	Sex		Undetermined	Total	
	Male	Female		No.	Per cent
0-1			2	2	6
1-2			3	3	10
4-5			1	1	3
5-6	1	4		5	17
6-7	2	1		3	10
7-8	3	1	1	5	17
8+	10	1		11	37
Adult?		1		1	3
	16	8	7	31	

Fig. 3. The remains of a large bull reindeer which became entangled in wire near the abandoned Coast Guard station. 7/18/57.

Fig. 4. Large bull reindeer east of Big Lake. Note the large antler size. 7/20/57.

PHYSICAL CONDITION AND CHARACTERISTICS OF THE REINDEER

During the course of the study twelve reindeer were shot from representative sex and age groups within the population. These animals were examined to determine their physical characteristics and well being. Body and antler measurements and weights were obtained and examinations were made for parasites and other pathologic conditions. All animals collected were in excellent physical condition. Fat deposition was particularly noticable in the large bulls but actively growing yearlings and lactating cows were also in good flesh with mesenteric, subcutaneous and intermuscular fat present. Subcutaneous fat was pink in all of the specimens, indicating that fat anabolism was taking place. The two large bulls collected had fat layers on their rumps three to four inches thick. Hadwen and Palmer (1922) list October as the period when reindeer have attained their maximum fat reserves. Weights and measurements, taken from the animals collected, are shown in Table 4. The weights of all of the reindeer collected are greater than the average weight range listed for reindeer from other Alaska herds.

Also conspicuous among these animals was the very large and uniform antler growth on all sex and age groups. "Trophy size" antlers were common among the large bulls. The measurements from the three large bulls compare favorably with caribou antler measurements and these were by no means the largest animals present. Figures 5 through 10 show the range of antler development on some of the reindeer specimens collected.

No warbles, nose bots or other external parasites were found in the specimens collected. Although the 12 animals collected is admittedly a small sample, this indicated absence of warbles and nose bots corresponds with conditions on St. Lawrence Island where the reindeer herd was free of these parasites for several years after its establishment (Hadwen and Palmer, 1922). The original stock was moved to St. Matthew Island in August when it is most likely all the bot fly and warble grubs had left the reindeer and egg laying had not started. Mr. Fred Chase (letter), Nunivak Island reindeer manager, has suggested that climatic conditions, rather than isolation, may be the important factor on St. Matthew Island in keeping the animals free of insect parasites.

All reindeer specimens examined were free of parasites of the lungs and liver and complete examination of the digestive tract of four reindeer failed to reveal parasites. Again, the extremes in weather conditions on St. Matthew Island may be detrimental to the completion of the exoteric stage of the life cycles of some internal parasites. Of course, there are many parasites which are not eliminated by climatic extremes and these are quite likely present in the herd but might not be found in healthy animals. The significance

Fig. 5. Female fawn, No. 15, weight 107 pounds, antler beam 12 inches. 8/7/57.

Fig. 6. Female fawn, No. 11, weight 97 pounds, antler beam 10 3/4 inches. 8/3/57.

Fig. 7. Yearling Cow, No. 16, weight 211 pounds, antler beam 21 1/4 inches. 8/8/57.

Fig. 8. Yearling bull, No. 9, weight 235 pounds, antler beam 30 1/2 inches. 8/1/57.

Fig. 9. Four year old cow, No. 14, weight 247 pounds, antler beam 26 inches. 8/7/57.

Fig. 10. Old bull (9 ½ years), No. 13, weight 404 pounds, antler beam 49 1/2 inches. 8/4/57.

TABLE 4

PHYSICAL CHARACTERISTICS OF ST. MATTHEW ISLAND REINDEER, 1957

Collected	Age (yrs.)	Sex	Total Weight	Hind Foot	Chest Girth	Total Length	Length of Longest Beam of Antlers
8/3	fawn	F	97	15.75	36.50	50.75	10.75
8/7	fawn	F	107	16.00	38.50	53.25	12.00
8/8	1	F	186	17.00	43.50	59.50	23.00
8/8	1	F	211	18.25	45.00	61.00	21.25
8/1	1	M	235	18.00	46.75	62.50	30.50
8/4	1	M	219	18.75	46.00	61.75	26.75
8/3	3	F*	245	18.50	48.50	70.75	18.50
7/17	4	F	----	19.00	44.75	68.25	----
8/7	4	F*	247	17.25	45.50	69.00	26.00
7/17	7	F*	----	18.25	47.00	66.50	----
7/20	8+	M	----	21.25	55.00	82.00	41.00
8/4	8+	M	404	19.25	62.50	77.25	49.50

* Lactating.

Fig. 11. A band of reindeer (mostly cows and fawns). Note the large size of the fawns. 8/3/57.

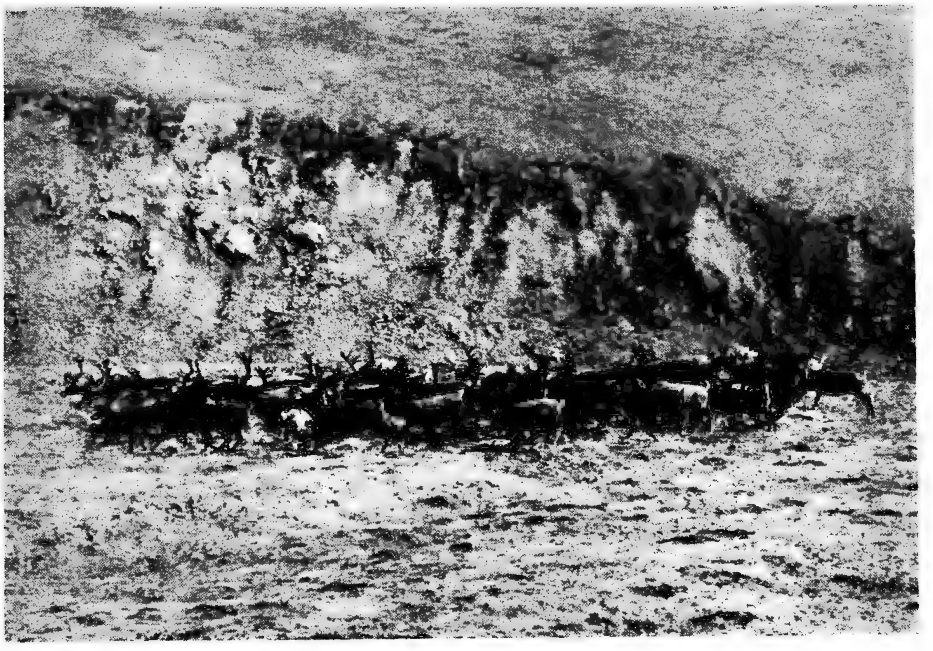

Fig. 12. A band of reindeer running from the observer. The smooth body contours, characteristic of fat animals, are quite apparent. 8/3/57.

of the indicated low incidence of internal parasites in these reindeer is apparently not due to their isolation but more likely is a reflection of the excellent physical condition of the animals.

The general well being of these reindeer, which is reflected in their large body size and antler development, abundant fat reserves and relative absence of parasites, are obviously reflections of aspects of their environment. In this respect, the quality of the summer forage is perhaps most instrumental, as the physiological requirements for growth and development are the highest during the summer season.

THE REINDEER RANGE

A survey of the vegetative complex of the island was made through the use of point-intercept transects, meter-square quadrats and extensive plant collections. On the line transects and quadrats, vegetation was recorded by ground cover, frequency of species occurence, vigor, utilization by reindeer and total aspect. A representative collection of plants was made from the entire reindeer range. One hundred and fifty-eight specimens were collected, representing one hundred and twenty species. Appearance of the vegetation and general aspect of the range was recorded photographically.

Twelve point-intercept transects, one hundred feet long and with recording points at one foot intervals, were established in varying stands of vegetation throughout the island. These transects were laid out with a steel tape and marked at both ends with rock cairns. A photographic record was obtained for each transect in color and black and white. Locations of the transects were recorded in the field notes and on aerial photos. The information recorded from the transects is summarized in Appendix Table 2. An accompanying map shows the locations of the transects (Fig. 1).

Three groups of one-meter-square vegetative study plots were established on sections of the reindeer winter range. Each group consists of four one-meter-square plots laid out in close association as shown in Figure 1. Two of the plots in each group were protected from reindeer grazing and trampling by five feet of cattle fencing topped with two strands of barbed wire (Fig. 15). The two remaining plots were unprotected and available to use by reindeer. The ground cover in each of the plots was recorded by species, area covered and height and charted on graph paper at the scale of 1:5. The plots were photographed in color and black and white and a soil well was dug near each group from which samples and a description of the soil profile were obtained. The vegetative analyses of the quadrats and the soil characteristics are listed in Appendix Tables 3, 4, 5 and 6. The locations of the quardats are marked on the map in Figure 1.

Fig. 13. The low dry flats at the southeast end of the island. These flats are grazed heavily during the winter by reindeer. Cape Upright is in the distance across the flats. 7/22/57.

Fig. 14. Looking northwest across Big Lake to Glory of Russia Cape on right horizon. Note "rock pavement" in the foreground and the darker sedge meadows adjacent to the stream. 7/22/57.

Fig. 15. Range enclosure (Station 2) on the dry flats near Big Lake. The darker raised hummocks of willows with lighter, shattered lichens between are characteristic of over-grazed reindeer range. 8/3/57.

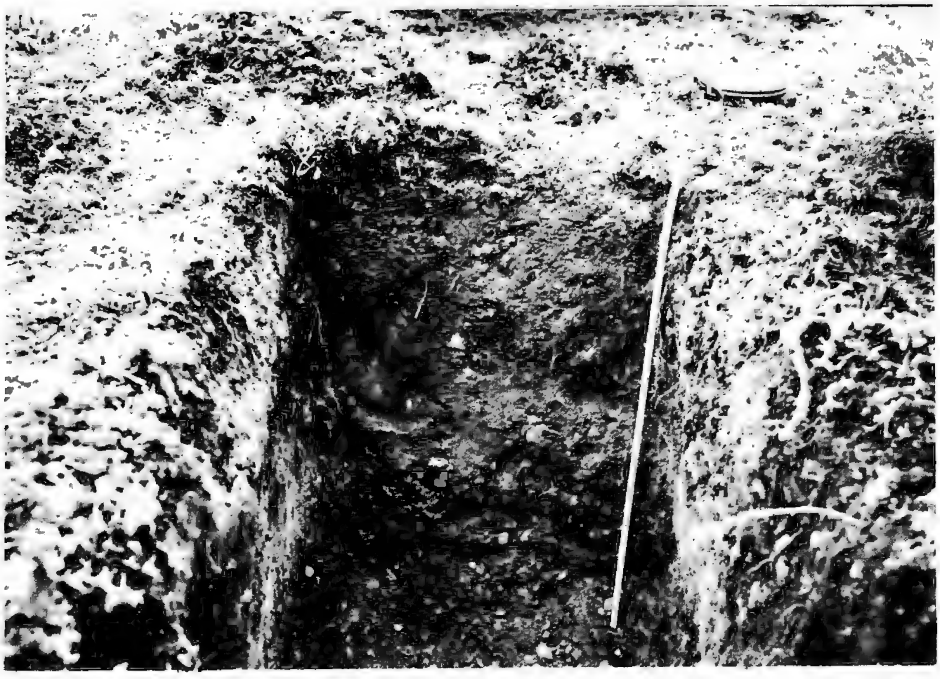

Fig. 16. A soil well at Station 2 showing the profile of the well-developed, gravelly loam soil. Note the root penetration to nearly 1.5 feet. 8/3/57.

Complex of Vegetation Present

Vegetation is of the arctic tundra type and is of a more xeric nature than that of the Pribilof Islands. Precipitation at St. Paul Island in the Pribilof group is greater than on St. Matthew Island and averages 24 inches annually. All plants are low growing and only the annual growth of a few forbs and grasses exceeds one foot in height. Willows, the only shrubs present, are decumbent forms. The major plant communities can be broken down into several groups, which are described briefly below:

1.) DRY FLATS: Extensive flats, with well-developed and well-drained rocky soils, are located northwest of Cape Upright and southwest of Big Lake. These flats support a dry tundra vegetation consisting mainly of lichens, willows and sedges. Soil wells disclosed no permafrost and its absence over the greater portion of the island is further indicated by the good soil drainage. Frost boils of 10 to 30 inches in diameter do occur. The dry flats have supported a greater intensity of winter utilization by reindeer than any other vegetative type. Consequently, lichens have been drastically reduced. The analyses of the vegetation at Station 1 and 2 and Transects 2 and 11, which appear in Appendix Table 2, 3 and 4, are typical of the dry flats (See Figs. 15, 16, 17 and 18). Plants occurring on the dry flats are listed below in their order of abundance:

Lichens: Cladonia alpestris, Sphaerophorus globosus, Cetraria cucullata and Thamnolia vermicularis are the most common forms, while other forms of Cladonia, Lobaria linita, Dactylina arctica, Cetraria islandica and Nephroma expallidum are also present.

Salix crassijulis x ovalifolia grows on raised hummocks a foot to several feet in diameter. Forms of S. arbutifolia replace S. crassijulis x ovalifolia with increased moisture or where temporary flooding occurs.

Carex nesophila is very common throughout the flats.

Mosses were apparently instrumental in building the hummocks upon which the willows grow and are mostly Polytrichum alpinum.

Other plants present, but scattered are:

Trisetum spicatum
Luzula arcuata
L. nivalis
Polygonum viviparum
Cardamine umbellata

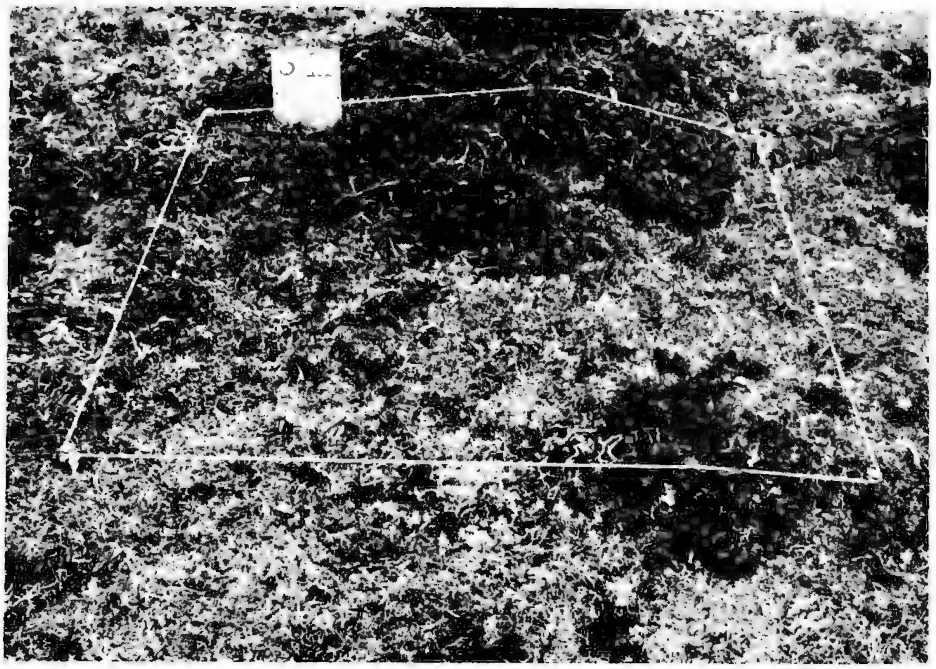

Fig. 17. A close-up of the vegetation in one of the permanent meter-square study quadrats at Station 2. The exposed stems of willows and badly shattered lichens are indicators of over-grazing. Compare this to Fig. 18 below. 8/3/57.

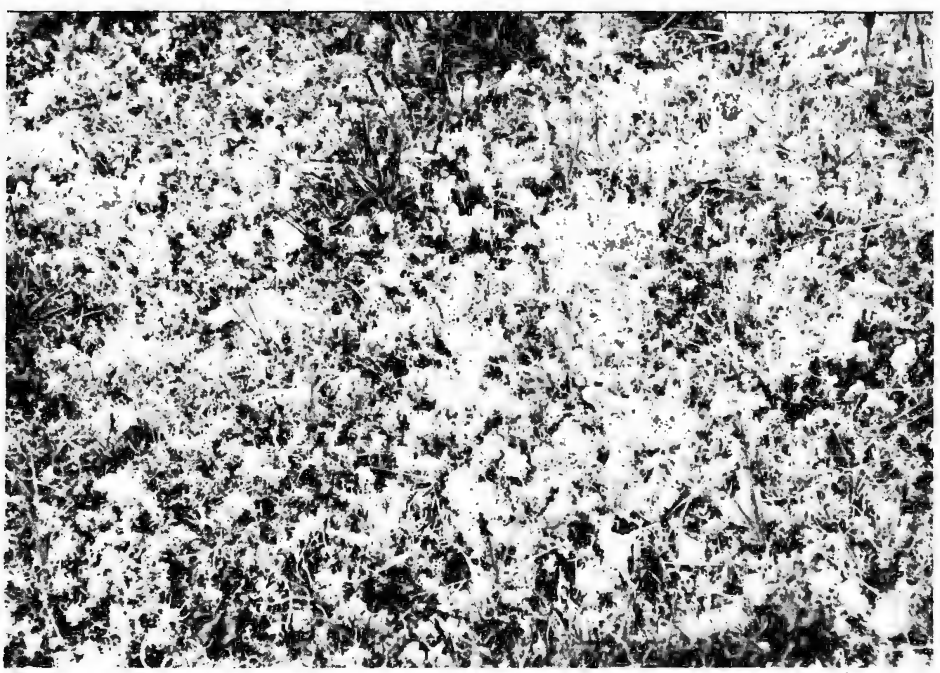

Fig. 18. Luxuriant lichen growth at the northwest end of St. Matthew Island which receives only light summer use by reindeer. Note the few willow leaves (very dark) in the lower center which are nearly engulfed by the lichens. 7/26/57.

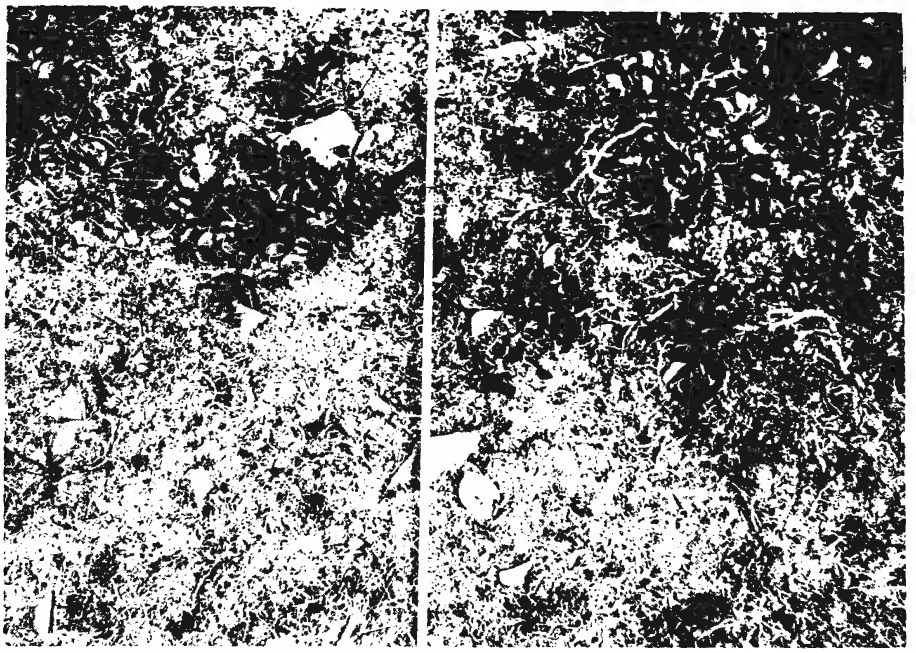

Fig. 19. Winter use by reindeer of this windswept low ridge has resulted in severe shattering and wind erosion of the lichens. Willows, although heavily browsed, show good recovery. (Transect No. 9) 8/3/57.

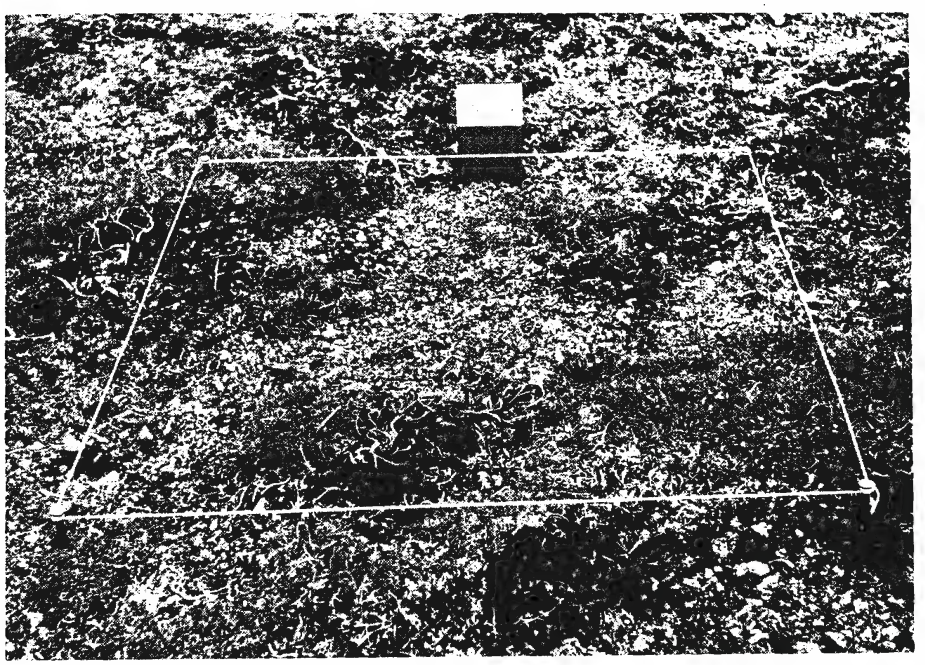

Fig. 20. Dryas, sedges and lichens predominate on the higher vegetated ridge tops (Station No. 3). The thinner lichen layer is rapidly lost through trampling and scattering by wind under heavy winter use by reindeer. 8/5/57.

Empetrum nigrum
Artemisia arctica var. beringensis

2.) DRY, LOW RIDGE TOPS AND BENCHES: Vegetation on level elevated areas where soil formation and "drainage" are good is quite similar to that found on the low, dry flats. Density and frequency of occurrence of willow (Salix crassijulis x ovalifolia) decreases with altitude and is usually replaced by Dryas octopetalla. Other more xeric plant forms are common on such sites. The lichen complex is similar to the dry flats but not as dense. Carex nesophila decreases in density. Moss is present but depauperate. The mineral soil is exposed more frequently. Vegetative composition of this community is analyzed in Appendix Table 2 and 5 under Station 3 and Transects 6, 7, 9 and 12 (See Figs. 19 and 20). In addition to the Dryas, willows, sedges and lichens, other plants occurring on these sites are:

Lycopodium alpinum
Festuca brachyphylla
Polygonum viviparum
Potentilla vahliana
Oxytropis nigrescens
Empetrum nigrum
Ligusticum macounii
Loiseleuria procumbens
Vaccinium vitis-idea
Androsace chamaejasme
Pedicularis sudetica
Campanula uniflora
Artemisia arctica var. beringensis
A. trifurcata
Senecio atropurpureus

3.) MOIST, WELL-DRAINED MEADOWS: On these sites sedges are predominant but ground cover is complete and a wide variety of arctic alpine forbs exists. Carex nesophila is the predominant sedge. Willow is primarily Salix rotundifolia, which forms dense mats particularly when associated with snowflushes, and S. reticulata, which is usually scattered but more apparent because of its larger leaves. Lichens are very scattered on such sites. Frequently, residual snow banks furnish abundant moisture throughout the summer on these meadows. Transects 1 and 10 were laid out in these plant communities and their summaries are presented in Appendix Table 2. Figure 14 shows the typical association of these types. Additional plants occurring on the moist, well-drained meadows are:

Lycopodium selago
Alopecurus alpinus
Arctagrostis latifolia
Calamagrostis deschampsioides
Poa arctica
Carex bipartita
Luzula wohlengergii
Aconitum delphinifolium
Sedum roseum
Saxifraga hieracifolia
S. punctata
Gentiana glauca
Lagotis glauca
Pedicularis capitata
Valeriana capitata
Artemisia arctica var. beringensis

4.) WET, POORLY-DRAINED MEADOWS: Bog meadows are common in some sections of the flats, in broad valleys and low mountain passes where level ground is poorly drained. Sedges predominate in such sites. Eriophorum angustifolium and E. russeolum var. albidum are very common but do not form true hummocks characteristic of the sub-arctic muskegs. Carex stans and C. bipartita occur as codominants on these sites and are grazed heavily by reindeer in the summer. The intervening areas between the sedges are occupied by Sphagnum sp., other mosses, a few lichens (Cladonia alpestris, Thamnolia vermicularis and others) and such higher plant forms as Petasites frigidus, Rubus arcticus, Potentilla palustris and Salix arbutifolia. The vegetative summaries from Transects 4 and 5 (Appendix Table 2) are typical of the bog meadow type (Fig. 21). Evidence of the presence in the past of permafrost on the island is indicated in some of the low bog meadows where "pingo" mounds have been pushed up by frost action (Fig. 22).

5.) ROCK RUBBLE FIELDS AND HIGH RIDGE TOPS: Vegetation on high rock rubble fields and ridge tops of frost-sorted scree is mainly restricted to crustose lichens. Frost action is very apparent in these locations, forming stone polygons and stripes, and on the ridge tops, sorting the scree into a "pavement" of rocks of uniform size (Fig 14). Soil formation is very limited, occurring in pockets where fine material has been brought to the surface by frost boils. Where protection from the wind is afforded, these soil pockets support lush growths of lichens, including Cladonia alpestris, Sphaerophorus globosus and others. Carex nesophila is interspersed with the lichens. Unfortunately, the total area occupied by the "pockets" of vegetation is small.

Fig. 21. On the sedge meadow, typical of poorly drained sites, cotton grass, Eriophorum angustifolium, often forms nearly pure stands. 7/18/57.

Fig. 22. Inactive "pingo" mounds are evidence of the presence of permafrost sometime in the past. These bog meadows are grazed heavily by reindeer during the summer. 7/28/57.

Fig. 23. An almost pure stand of crowberry, Empetrum nigrum, on the narrow strip of land between Big Lake and the sea. Note the old polar bear trail (at least 75 years since used) which bisects the picture. 7/19/57.

Fig. 24. These exposed stems and roots of willow are the result of browsing, trampling and pawing by reindeer. 7/18/57.

6.) STABILIZED BEACH RIDGES: Immediately behind the gravel beaches are located bands of almost pure stands of Elymus mollis on the old, raised beaches. Stabilization of the sand and gravel of these old beaches is taking place, however, "washouts" from recent storms are evident. Scattered through the stands of Elymus are Angelica lucida, Lathyrus maritimus, Cochlearia officinalis, Senecio pseudo-arnica and Calamagrostis deschampsioides.

Several other vegetative types, or plant communities, are present on St. Matthew Island but they are of less importance as reindeer range and occupy restricted areas.

Immediately inland from the Elymus beach ridges, between Big Lake and the sea, is a flat expanse about 300 yards wide by four miles long which is grown almost exclusively to Empetrum nigrum (Fig. 23). It is a dry, well-drained flat, with a very thin soil layer overlying coarse irregular-shaped gravel. Widely scattered in this matrix of Empetrum, which is quite depauperate, are plants of Salix arbutifolia, Oxytropis nigrescens, Artemisia arctica var. beringensis and Deschampsia caespitosa. A few other examples of this community are found under similar conditions throughout the island but they are quite limited in size.

Adjacent to several of the large lakes are flood plains which are inundated annually or every few years. Water levels in the lakes can be raised through storm tides, which flood over the beach dykes, excessive spring runoff and raising of the beach dykes through wave action. These flood plains, with rich alluvial soils, support lush growth of grasses and some forbs and willows. Deschampsia caespitosa is the dominant grass often forming pure stands. Forms of Salix arbutifolia occur commonly on these sites as well as Rumex fenestratus. The vegetation recorded in Transect 8 in the Appendix, is typical of these lake flood plains.

Other vegetative types occupying limited areas include: Lake shores with rushes, Potentilla palustris and Ranunculus hyperboreus predominant; lakes and ponds where Hippuris vulgaris, Equisetum palustre and Potamogeton sp. are present; and cliff faces where Cochlearia officinalis, Arenaria peploides, Claytonia acutifolia and a few grasses grow luxuriantly in the crevices in the rock, fertilized by droppings from the sea birds.

Summer Range Use

Evaluations of range condition and the effect of ungulate utilization are difficult tasks on any range. On the tundra biome, where perennial growth does not exceed a few inches, variations in range conditions are not obvious. Lacking accurate knowledge of the appearance of the range in previous years, a certain amount of

speculation is involved in estimating changes that have taken place. Until several years accumulation of systematic vegetative measurements are available, rather general observations of indicator plants and apparent vegetative changes resulting from reindeer activity, must be relied upon.

Summer forage, for reindeer on St. Matthew Island, shows no apparent deterioration through over-utilization by the present reindeer herd. During the field studies, reindeer were observed to use the well-drained sedge meadows and bog meadows almost exclusively for summer grazing (Types 3 and 4). In these types, sedges are dominant, or very common, and are eaten extensively by the reindeer. On the drier, better-drained meadows, Carex nesophila is the most abundant sedge and receives the brunt of summer use, while the wetter, boggy sites support a wider variety of sedges but C. stans is usually the dominant form and receives the heaviest use. Other sedges, leaves stripped from willows, grasses and forbs are also important components of the summer diet of reindeer. Frequently, the flowering or fruiting parts, were all that were eaten from some plants, such as Rumex fenestratus and Arnica lessingii. All vegetative types receive some summer use by reindeer, however, only the types with a high proportion of sedges are utilized consistently.

The quality of the low-growing plants of the arctic tundra, which make up the summer forage, are apparently highly nutritious, as reflected in the excellent physical condition of the reindeer. The high nutritional value of some types of arctic vegetation, which is associated with the long daily solar radiation, has been known for some time (Curtis and Clark, 1950). On St. Matthew Island the variations in exposure, resulting from irregularities in terrain, account for a wide range in plant development and maturity. Also, the cool moist summers delay maturity and curing of vegetation. Consequently, vegetation during its most highly nutritious period, the early stages of growth, is available for an extended period throughout the summer.

The effects of current use of sedges, grasses and forbs was readily apparent on the range, however, previous year's utilization was not evident on such plant forms. Summer grazing is apparently seldom permanently destructive to this type of summer forage and indications are that limited grazing of annual growth of sedges, grasses and some herbs is actually beneficial in stimulating forage production. Harmful effects of the reindeer on the summer range are limited to trampling of vegetation and compacting of loose, moist soil where movements of large numbers of animals are constricted in narrow valleys and by other terrain features. Throughout the spring and summer, when the vegetation is growing, plants are able to withstand considerable trampling and recover rapidly. In addition, the high humidity, which accompanies the persistent spring

and summer fogs, keeps the lichens moist and resilient and less subject to crumbling than in a drier atmosphere or during the winter.

At the time of the study, summer reindeer range on St. Matthew Island showed no significant permanent damage as a result of reindeer activity. Evidence, from other reindeer ranges in Alaska, indicates that summer range seldom suffers from over-utilization, while winter range conditions appear to be the most important population controlling factors. However, the importance of summer range, in the ecology of reindeer, may be greater on an island where opportunity for movement is restricted. In addition, the favorable condition of the summer range, under the present stocking of about 1,350 reindeer, is not necessarily indicative of the carrying capacity of the area, in view of the short time this number has been present on the range. By referring to the growth curve in Figure 2, it is apparent that in 1955 there were only about 800 reindeer, while two years earlier less than 500 were present on the island. Unfortunately, the indicators of range deterioration on summer range are much less apparent than on winter range, yet the importance of high quality summer forage for growth and development of all grazing animals is of unquestionable value.

Winter Range Use

Winter reindeer range on St. Matthew Island is necessarily restricted to windswept areas which are blown free, or nearly free, of snow by the prevailing northeast winds of winter. Stream valleys, depressions and the lee side of hills, accumulate drifted snow which greatly restricts availability of vegetation in these areas. By nature of their exposure and lack of significant snow cover, the windswept areas support xeric plant communities, which reflect their harsh microclimatic environment. A lichen-willow-sedge complex predominates on the winter range. The analyses of the vegetative complex of sections of the winter range are included in Appendix Tables 2, 3, 4 and 5 under Stations 1, 2 and 3 and Transects 2, 6, 7, 9, 11 and 12.

Up to the present, the greatest concentration of winter use by reindeer, has been on the two areas of large dry flats and adjacent low ridges on the southeast end of the island (Figs. 13 and 15). Late winter aerial observations, made by Rhode in 1955, revealed large numbers of reindeer using these areas. As one travels northwestward, up the length of the island, evidence of winter utilization, such as winter droppings, shed antlers and lichen deterioration, becomes less common and finally disappears completely at the extreme end. The northwest end of the island, north of 940 in Figure 1, has no extensive flats and is interrupted by many small valleys and intervening ridges. There are also extensive areas of "rock pavement" where soil development has not taken place. These veritable

Fig. 25. Luxuriant growth of the worm-like lichen, Thamnolia vermicularis, on reindeer-free Hall Island. Note that no shattering of the lichens has taken place here. 8/9/57.

Fig. 26. Remains of an old fox trapper's cabin east of Big Lake. Note the abundance of driftwood. 8/8/57.

deserts on much of the northwest end of the island apparently result from the absence of surface water, due to the excellent drainage afforded by the decomposing bedrock. The entire northwest end apparently receives only limited summer use by a small number of large bulls.

Vegetation on the heavily utilized wintering areas adjacent to Big Lake and Cape Upright readily shows the effect of reindeer use. Lichen growth has been seriously depleted through the combination of winter grazing, trampling and shattering and actual removal of the dry, shattered pieces of lichen by the persistently strong winds. With wind velocities often averaging in excess of 20 knots during winter months, the potential for plant desiccation and erosion is great (See Weather Summary, Appendix Table 1). Lichen growth, which formerly occupied the slight depressions between the raised hummocks of prostrate willows, has been almost completely removed. Lichen growth on these over-grazed areas apparently was quite similar in the past to ungrazed areas at the northwest end of the island and on reindeer-free Hall Island where the lichen mat is 3 to 4 inches deep (Figs. 18 and 25). Now the lichen mat on the winter range seldom exceeds an inch in depth and is composed of badly shattered lichens unattached to the ground. Unfortunately, the preferred lichen species, such as Cladonia alpestris, are the most vulnerable to shattering through trampling, while the more resilient forms which resist shattering, such as Thamnolia vermicularis, are less palatable to reindeer and make up a smaller percentage of the original stands.

The willows on the winter range have fared somewhat better than the lichens and in fact, have increased their area of ground coverage as competition with the lichens decreased. In similar lichen-willow-sedge stands at the northwest end of the island, which have not been utilized by reindeer, the willows and sedges have been suppressed by the engulfing growth of lichens. While the removal of lichens on the winter range has stimulated growth of willows and sedges, more recently reindeer have been forced to rely heavily on the willows with the result that evidence of this heavy use is also apparent on these prostrate shrubs. Exposed stems and some "die back" occur on willows throughout the dry flats and low ridge tops at the south end of the island as a result of reindeer browsing, pawing and trampling. Widely scattered willows growing in the Empetrum nigrum flats, between Big Lake and the sea, have suffered the greatest damage from pawing.

Sedges on the winter range have apparently increased as a result of the reindeer activity on the lichens much the same as the willows have. However, while the willows have increased their ground coverage wholly through expanded growth of existing plants, the sedges appear to have extended their coverage through both rhizome sprouting and reseeding. Also, the sedges which are mostly Carex nesophila, have not been important constituents of the reindeer's winter diet while lichens were abundant, although they are utilized extensively

during the summer. Evidence from other reindeer ranges indicate that when lichens are depleted, grasses and sedges are grazed extensively during the winter (Palmer, 1929).

On the dry flats where utilization by reindeer has been most intense and the lichen flora has been virtually eliminated, some wind erosion of the fine organic surface duff has taken place. The mineral soil is not as susceptible to wind erosion due to its high moisture content from frost thawing in summer and its frozen nature in winter. The surface character of the flats, with the raised hummocks of willow and intervening depressions occupied by the lichens and sedges, also tends to preclude wind erosion. Frost boils are common throughout the flats and can be mistaken for erosion due to reindeer activity, particularly so when the imprints of several hooves remain in the firm mud of the boils. The windswept, vegetated ridge tops, which are segments of winter range, are more readily eroded by wind action when the vegetative cover is disrupted. On these sites both the plant cover and the layer of organic duff are much thinner than on the lower flats and the effect of feeding and trampling by reindeer is more pronounced. Evidence of moderate to severe wind erosion of both the organic surface layer and the finer mineral soil were encountered on the more exposed ridges where wind velocities are greatest. Figure 20 shows the effects of wind erosion in exposing the roots of Dryas and in the establishment of a pebble layer as the finer mineral soil has been blown away.

Invasion of deteriorated lichen-willow-sedge range by other less desirable species has not occurred to a significant extent. On a few of the more xeric low ridges and slopes, the impression is gained that Dryas and Empetrum have increased their area of surface coverage as the destruction of the lichen growth exposes more mineral soil. However, the growth of dense mats of Dryas and Empetrum are restricted in area and occur only on the dry and exposed ridge tops and old gravel flats adjacent to the beach.

Extensive reindeer trails, such as are characteristic of long-used caribou range, are not found on the island. Single trails have developed through narrow passes, in V-shaped canyons, and where lake shores crowd adjacent hillsides. Apparently, the movements of reindeer on the island are dispersed and not usually en masse so that the parallel trails of migration found on caribou ranges have not developed here.

CONCLUSIONS

It is obvious, from the herd counts and the projected population growth curve (Fig. 2), that the reindeer on St. Matthew Island have rapidly increased in 13 years to occupy an apparently very favorable virgin range. At their present rate of increase, saturation of the

range is imminent. Fawn counts indicate that over-population is beginning to have its effect on productivity. Present density on the island is 10.5 reindeer per square mile, however, the north half of the island is not used extensively as winter range and topography and edaphic conditions limit its value for future use. Also, tallus slopes and rock rubble fields on mountain sides and ridges, reduce the total usable range. Consequently, reindeer use is concentrated on a much smaller total area. Palmer (1929) lists 10 to 16 deer per square mile as the maximum allowable for safe range use and he later suggested that this might be too high a density for most ranges. If only utilizable range is considered, reindeer density on St. Matthew Island is already in excess of Palmer's figure. On St. Paul Island in the Pribilofs, reindeer reached a density of 49 animals per square mile just prior to the "crash die off" (Scheffer, 1951).

Deterioration of the lichen range has been in progress for at least the past 3 to 4 years. Willows also show the effects of over-utilization. Comparison of the most heavily used wintering areas with similar areas at the northwest end of St. Matthew Island and on adjacent Hall Island show marked contrasts. Lush, undamaged lichen growth 3 to 4 inches thick is still common (but scattered) on the northwest end of St. Matthew Island and on reindeer-free Hall Island. On the large dry flats, which comprise the most extensive wintering areas, lichens are no longer the important component of the available winter forage that they have been in the past. While early quantitative reports of the vegetation of St. Matthew Island are lacking, general observations by early explorers and naturalists indicate that a lush lichen flora was a distinct characteristic of the vegetative complex of the island prior to the release of the reindeer (Hanna, 1920; Beals, 1944).

The immediate effect of a reindeer population in excess of the available range on the vegetation of St. Matthew Island will be quite noticable in altering successional stages. Indications of such changes taking place are already apparent. However, it is doubtful that the survival of any plant species is in jeopardy. Many local refugia exist due to the variations in terrain and associated winter snow accumulations in which plants are completely protected from destructive activity. Scheffer (1951) found on the Pribilof Islands that after the reindeer die off had occurred and the range was depleted, isolated areas of lichens and other plants remained in areas seldom visited by the reindeer.

It is felt that bird life on the island will not be seriously affected by the increasing reindeer herd. The reindeer are in no conflict with the thousands of cliff nesting sea birds, or the snowbuntings, redpolls and rosy finches, which nest in the higher, rocky terrain of the island. Undoubtedly, the sandpipers and few

ducks that nest in the lower, boggy areas will suffer occasional nest mortality from trampling by reindeer, however, this should not be excessive in view of the wide dispersal of the reindeer in the summer nesting season and their restricted use of certain areas of the island.

RECOMMENDATIONS

At the present time, harvest of the reindeer on St. Matthew Island for food purposes is economically impractical. The inaccessibility of the island, the absence of an available human population as a labor source and the lack of a demand for the meat contribute to this situation. Complete removal of the herd to alleviate future problems of over-population and range deterioration, while desirable, would involve seemingly insurmountable obstacles. Extreme logistical problems and the persistent summer fogs would render "clean up" of the last few animals a long and difficult task.

In view of the fact the management of this reindeer herd is impractical and there are no other range priorities planned for the island in the near future, it is recommended that the St. Matthew Island reindeer herd be used as an experiment in population dynamics and range ecology. Merely by following a laissez-faire policy with the herd, much valuable information of reindeer-range relationships will become available as the population builds to its peak and the expected crash decline follows.

It is desirable that annual, or at least periodic, counts of the population be made to enable plotting of the trend in growth and pinpointing the peak of the cycle. The population decline may be rapid after the peak is reached. The reindeer herd on St. Paul Island showed a loss of 37 per cent in one year after the population high. Counts could possibly be accomplished through cooperation with the Navy or Air Force. Vertical photographic coverage of the reindeer when they are concentrated on the wintering areas would enable relatively accurate counts. The Navy makes periodic weather reconnaissance flights over this area and would have the best opportunity to choose favorable weather for photographic purposes. Perhaps a Fish and Wildlife Service representative could go along on one of the flights and assist in the photographing.

Following the peak of the reindeer population cycle on St. Matthew Island, the vegetative study plots and transects should be re-examined to evaluate the changes in the range which have taken place. Until this occurs, periodic checks of the range would be desirable.

APPENDIX - TABLE 1. ST. MATTHEW ISLAND CLIMATOLOGICAL DATA

September 1943 - August 1944
(Recorded by U.S. Army)

	Temperature			Precipitation		Wind			Fog
Month	Max.	Min.	Ave.	Total Precip.	Total Snow On Ground	Prevailing Direction	Ave. Speed	Extreme Speed	Hours of
Sept. 43	45.6	37.2	41.4	2.08	0	NNE	14.6	40+	110
Oct. 43	39.2	32.4	35.8	1.81	0.2	NNE	13.7	48+	63
Nov. 43	32.7	26.5	29.7	1.40	2.8	NNE	17.0	42+	15
Dec. 43	20.5	12.1	16.1	0.82	11.0	N	17.9	60+	5
Jan. 44	12.4	0.7	6.6	0.84	16.7	NE	26.1	80+	148
Feb. 44	21.1	10.1	15.4	1.46	16.4	NNE	23.9	60+	143
Mar. 44	15.4	7.0	11.0	0.32	13.0	NNE	20.3	65+	141
Apr. 44	24.5	11.9	18.4	0.52	10.2	NNE	19.6	45	108
May 44	35.4	27.5	31.5	0.82	3.5	NNE	12.4	36	267
June 44	41.3	33.0	37.2	0.89	0.3	NNE	10.7	37	376
July 44	47.8	39.4	43.7	1.47	0	NNE	9.7	35	468
Aug. 44	49.0	42.9	45.9	2.89	0	W	10.2	32	401
TOTAL				15.32					

APPENDIX - TABLE 2. SUMMARIZATION OF DATA OBTAINED FROM 12 POINT INTERCEPT TRANSECTS, ST. MATTHEW IS., 1957

(Intercept points every foot on a one hundred foot line)

INTERCEPTIONS PER 100 CONTACT POINTS

SPECIES (or ground cover)	Transect Number 1	2	3	4	5	6	7	8	9	10	11	12
Lichens - Total		37	37	41		9	20		50		41	3
Cladonia alpestris		24	31	32		3	16		42		33	2
Thamnolia vermicularis		5	5	9		3			6		2	
Sphaerophorus globosus		8				3	4		2		6	
Dactylina arctica												1
Lobaria linita			1									
Carex nesophila	20	11	7			18	20		17	6	38	16
C. stans				17	62							
Eriophorum augustifolium and E. russeolum				2	4							
Luzula arcuata						3	1		1		1	1
Deschampsia caespitosa								58				
Arctagrostis latifolia								1		13		
Poa arctica		1										
Salix reticulata	38						3		1			4
S. rotundifolia	18											2
S. crassijulis x ovalifolia		4	3			14	4		12	3	7	
S. arbutifolia				19	1					11		
S. arbutifolia x ovalifolia								22				
S. ovalifolia												12
Empetrum nigrum		17	44				26					41
Vaccinium vitis-idea												1
Cornus canadensis										3		
Artemisia trifurcata		1				1				1		
A. arctica var. beringensis	11									24		2
A. tilesii										1		
A. senjavinensis						1						
Arnica lessingii	6									2		
Petasites frigidus				5	5							
Dryas octopetala							10					4
Rubus arcticus				1	2					6		
Potentilla palustris				1								
Saxifraga punctata	1				1							
S. hieracifolia					2							
Sedum roseum	2	1							3	13		
Arenaria arctica		1							1		3	3
Loiseleuria procumbens							1					
Ligusticum macounii												1
Rumex fenestratus								12				
Polygonum viviparum												1
Polemonium acutiflorum				1	2					4		
Angelica lucida										1		
Equisetum arvense			5						3			
Sphagnum sp.				7	12							
Moss- mostly Polytrichum alpinum	4	27	4	6	9	39			7	5	10	4
Exposed soil							3	7		7		5
Gravel & pebble surface						15						
Rocks of varying sizes							12		5			

APPENDIX - TABLE 3 VEGETATIVE COMPOSITION AND GROUND COVER WITHIN THE METER SQUARE STUDY PLOTS AT STATION NO. 1

Station #1, July 21, 1957, St. Matthew Island.
Located approximately ¼ mile south of small lake at northwest corner of flats northwest of Cape Upright. Cape Upright approximately 5 miles to the southeast. Elevation 15 feet, site level. Dry lichen-willow-sedge tundra. Lichens badly shattered and mixed with some detached dead moss. Lichen layer averages ½ inch deep and is composed predominately of Sphaerophorus globosus, Cetraria cuculata, Thamnolia vermicularis and scattered and finely broken pieces of Cladonia alpestris. Some frost boils present. Heavily utilized by reindeer in the winter. Willows and other plants in vigorous condition.

The north and south plots, I and III, are protected from reindeer grazing by fencing. The east and west plots, II and IV, are unprotected. The fence enclosure is 9 by 15 feet. The site photograph of the enclosure was taken 50 feet east of the enclosure from a permanent photo-recording stake.

		PER CENT OF TOTAL AREA			
Grid Key	GROUND COVER	Plot N I (enclosed)	Plot E II (unprotected)	Plot S III (enclosed)	Plot W IV (unprotected)
12	Shattered lichens with a few unattached dry mosses	68.5	77.6	79.6	76.7
3	Salix crassijulis x ovalifolia	13.7	6.6	9.7	10.6
2	Carex nesophila	4.0	10.6	8.0	7.2
1	Luzula arcuata	.7	2.4	1.2	1.1
10	L. nivalis				.4
6	Trisetum spicatum	.1			1.0
3	Arenaria arctica	2.8	1.7	.8	1.3
11	Artemisia trifurcata				.1
8	Pedicularis sudetica	.1	.1		.1
7	Vaccinium vitus-idea	.3		.2	
9	Moss (Polytrichum alpinum)	.4	1.0	.4	1.6
4	Gravel (frost boils)	9.4			

APPENDIX - TABLE 4. VEGETATIVE COMPOSITION AND GROUND COVER WITHIN THE METER SQUARE STUDY PLOTS AT STATION NO. 2

Station #2, August 2, 1957, St. Matthew Island.
Located approximately ¼ mile southwest of the south corner of Big Lake. Elevation 15 feet, site level. Dry lichen-willow-sedge tundra. Lichens badly shattered and mixed with some detached dead moss. Composition of this lichen-moss layer varies from 80% lichen - 20% moss to 55% lichen - 45% moss and from ½ to 1½ inch thick. Its predominant lichen species are Cetraria cuculata, Sphaerophorus globosus, Thamnolia vermicularis and Cladonia alpestris. This area is heavily utilized by reindeer in the winter but condition of lichens is slightly better than at Station #1.

The north and south plots, I and III, are protected from reindeer grazing by fencing. The east and west plots, II and IV, are unprotected. The fence enclosure is 9 by 15 feet. The site photograph of the enclosure was taken 50 feet east of the enclosure from a permanent photo-recording stake.

Grid Key	Ground Cover	PER CENT OF TOTAL AREA Plot N I (enclosed)	Plot E II (unprotected)	Plot S III (enclosed)	Plot W IV (unprotected)
15	Shattered lichens with some detached dry mosses	88.0	73.9	58.6	72.3
5	Salix crassijulis x ovalifolia	4.1	3.2	27.1	2.0
2	Carex nesophila	6.5	15.5	13.0	24.7
1	Luzula arcuata	.4	5.7	.6	.1
6	Trisetum spicatum	.5	.1	.1	.3
3	Arenaria arctica		.1		
8	Pedicularis sudetica	.1	.1		
13	Artemisia arctica var. beringensis	.2			
10	A. trifurcata	.1	.2		.4
12	Cardamine umbellata	.1	.1		
14	Polygonum viviparum			.1	
11	Lycopodium selago	.1	.1		
9	Moss (Polytrichum alpinum)	.1	.2		.3
4	Gravel (frost boils)	.4	1.2	1.1	

APPENDIX - TABLE 5. VEGETATIVE COMPOSITION AND GROUND COVER WITHIN THE METER SQUARE STUDY PLOTS AT STATION NO. 3

Station #3, August 5, 1957, St. Matthew Island.
Located approximately 1 mile east of east corner of Big Lake on first ridge top. Elevation 200 feet, site level. Dry lichen-willow-Dryas-sedge tundra. Much exposed soil and pebble layer from wind erosion. Lichen layer very thin, less than ½ inch and badly shattered. Some detached dry mosses also mixed with lichens. Lichens mostly Cetraria cuculata, Thamnolia vermicularis and some Cladonia alpestris. This is a windswept area which has received heavy winter utilization by reindeer. Wind erosion has been active.

The north and south plots, I and III, are protected from reindeer grazing by fencing. The east and west plots, II and IV, are unprotected. The fence enclosure is 9 by 15 feet. The site photograph of the enclosure was taken 50 feet west of the enclosure from a permanent photo-recording stake.

		PER CENT OF TOTAL AREA			
Grid Key	Ground Cover	Plot N I (enclosed)	Plot E II (unprotected)	Plot S III (enclosed)	Plot W IV (unprotected)
23	Shattered & depauperate lichens and unattached dry mosses	40.3	40.0	26.1	6.8
5	Salix crassijulis x ovalifolia	13.1	11.6	3.0	1.6
21	Dryas octopetala		1.4	11.1	23.3
2	Carex nesophila	11.1	10.0	6.7	7.1
1	Luzula arcuata	1.0	1.2	.4	.2
6	Festuca brachyphylla	1.3	1.3	.6	1.0
3	Arenaria arctica	.6	.1		
8	Pedicularis sudetica	4.5		.2	.3
14	Polygonum viviparum	1.2	1.7	1.1	.2
15	Oxytropis nigrescens	.9	1.1	.3	.2
16	Androsace chamaejasme	.7	4.4	1.0	1.6
18	Ligusticum macounii	.6	1.2	1.5	.2
19	Artemisia senjavinensis		.4		
24	Potentilla vahliana				.1
20	Campanula uniflora	.9	.7		.1
9	Moss (mostly Polytrichum alpinum)	1.2	.5	.7	1.1
4	Gravel (pebble layer)	15.0	11.6	26.3	38.5
17	Organic soil	11.7	12.7	20.7	17.6

APPENDIX - TABLE 6. SOIL SAMPLE ANALYSES FROM STATIONS 2 AND 3, ST. MATTHEW ISLAND

(pH determinations made by the U.S. Agricultural Experimental Station, Palmer, Alaska; soil colors based on U.S. Soil Conservation Service soil color Standards.)

STATION NO. 2

Surface vegetation similar to that within quadrats. Surface duff, dead plant parts, ¾ to 1 inch deep. Root penetration to 16 inches. No effervesence on all samples with 20% hydrochloric acid. All colors from moist soil. August 2, 1957.

Soil beneath surface duff to 11¼ inches:

Texture- loam; crumbles readily into soft aggregates 1/8 to ½ inch in diameter, moderately large numbers of small stones up to 1 by ½ inch, usually with rounded edges.

Color- dark brown to brown, 4/2 on 7.5 YR.

pH- 5.0

11½ to 17¾ inches (6½ in.):

Texture- loam; fairly sticky with rounded stones up to 1 by ½ inch, somewhat less numerous than in horizon above, crumbles readily to particles 1/8 by ¼ inch, crumbles more crisply than in horizon above.

Color- yellowish brown, 5/4 on 10 YR.

pH- 5.2

Below 17¾ inches to subsoil:

Texture- loam; somewhat sticky, feels like dough, in small aggregates 1/16 inch in diameter, soft, very numerous stones up to 1½ by 1/8 to ¼ inches occasionally larger, rounded, more numerous stones than loam.

Color- yellowish brown, 5/4 on 10 YR.

pH- 5.2

APPENDIX - TABLE 6. (continued)

STATION NO. 3

Surface vegetation similar to that within quadrats. Surface duff 0 to ½ inch deep. Root penetration to 15 inches. No effervesence on all samples with 20% hydrochloris acid. All colors from moist soil. August 5, 1957.

Soil beneath surface duff to 3 inches:

Texture- loam; many gravel particles and small stones, unusually sharp angles, up to ½ to ¾ inch in diameter, very rich in organic matter.

Color- dark reddish brown, 3/3 on 5 YR.

pH- 5.7

3 to 9 inches (6 in.):

Texture- loam; somewhat sticky, with very sharp, had granular particles which break when subjected to considerable pressure, up to ¼ inch in diameter, these are lava particles, the material tends to form into compact masses, occasional irregularly shaped stones to 2 inches in diameter.

Color dark reddish brown, ¾ on 5 YR.

pH- 6.0

Below 9 inches to subsoil:

Texture- sand and gravel with very little silt, scattered small stones, rounded edges up to ½ inch in diameter, occasional larger irregularly shaped stones.

Color- dark brown, 4/3 on 10 YR.

pH- 6.7

APPENDIX- TABLE 7. LICHENS FROM A SAMPLE TYPICAL OF THE DRY FLATS AND LOW RIDGE TOPS OF THE REINDEER WINTER RANGE
(Near Station #2, August 2, 1957, St. Matthew Is.)

Order of Abundance	S P E C I E S
1	Cetraria cucullata (relative abundance greatest on heavily grazed areas)
2	Cladonia alpestris (best growth on ungrazed or lightly grazed areas)
3	Sphaerophorus globosus
4	Thamnolia vermicularis
common	Cetraria islandica
tr.	Lobaria linita (thallus form)
tr.	Dactylina arctica
tr.	Nephroma expallidum
tr.	Cladonia sp.

APPENDIX - TABLE 8 ST. MATTHEW ISLAND PLANTS COLLECTED DURING JULY 15 - AUGUST 9, 1957

Specimen Number	
83	Polytrichum alpinum Hedw.
73	Equisetum palustre L.
124	Equisetum arvense L.
65	Lycopodium alpinum L.
96	Lycopodium selago L.
68	Eriophorum angustifolium L.
62	Eriophorum russeolum var. albidum Nyl.
115	Carex nesophila Holm.
90	Carex membranacea Hook.
125	Carex bipartita Bellardi
1	Carex stans Drej.
99	Luzula nivalis (Laest.) Beurl.
126	Luzula multiflora (Retz.) Lej.
58	Luzula arcuata Wahl.
22	Luzula wohlenbergii Rupr.
64	Juncus castaneus Smith
102	Juncus biglumis L.
118	Hierochloe alpina (SW.) Roem. & Schult.
119	Festuca brachyphylla Schult.
13	Elymus mollis Trin.
54	Calamagrostis deschampsioides Trin.
85	Alopecurus alpinus J.E. Sm.
17	Arctagrostis latifolia (R. Br.) Griseb.
60	Trisetum spicatum (L.) Richt.
94	Deschampsia caespitosa (L.) Beauv. var. glauca (Hartm.) Sam.
14	Poa arctica R. Br.
5	Angelica lucida L.
117	Ligusticum macounii Coult. & Rose
74	Hippuris vulgaris L.
49	Valeriana capitata Pall.
113	Gentiana glauca Pall.
122	Gentiana algida Pall.
6	Pedicularis sudetica Willd.
45	Pedicularis capitata Adams.
106	Lagotis glauca Gaertn.
30	Androsace chamaejasme Host.
42	Primula tschuktschorum Kjellm.
2	Rumex fenestratus Greene
92	Loiseleuria procumbens (L.) Desv.
123	Polygonum bistorta L. ssp. plumosum (Small) Hult.
11	Polygonum viviparum L.
39	Oxyria digyna (L.) Hill.
41	Papaver radicatum Rottb. alaskanum (Hult.) J.P. Anderson

APPENDIX - TABLE 8. (continued)

80	Pyrola minor L.
82	Vaccinium vitis-idea L.
9	Empetrum nigrum L.
110	Campanula uniflora L.
4	Sedum roseum (L.) Scop.
27	Cornus canadensis L.
19	Claytonia sarmentosa C.A. Mey.
78	Epilobium latifolium L.
72	Epilobium anagallidifolium Lam.
51	Polemonium acutiflorum Willd.
131	Claytonia acutifolia Pall.
31	Arenaria arctica Stev.
134	Arenaria peploides L. ssp. latifolia (Fenzl) Maguire.
100	Lychnis macrosperma (Pors.) J.P. Anderson
46	Cerastium beeringianum Cham. & Schl.
47	Cerastium fischerianum Ser.
29	Dryas octopetala L.
87	Geum rossii (R. Br.) Ser.
40	Potentilla pacifica Havell.
79	Potentilla palustris (L.) Scop.
37	Potentilla vahliana Lehm.
81	Rubus arcticus L.
116	Oxytropis nigrescens (Pall.) Fisch.
43	Astragalus umbellatus Bunge.
52	Lathyrus maritimus (L.) Bigel.
108	Draba lactea Adams.
109	Draba stenoloba Ledeb.
32	Cardamine umbellata Greene.
8	Cardamine pratensis L.
130	Cochlearia officinalis L. arctica (Schlecht.) Hult.
50	Aconitum delphinifolium DC. paradoxum
103	Anemone narcissiflora L. sibirica (L.) Hult.
107	Anemone richardsonii Hook.
71	Ranunculus hyperboreus Rottb.
98	Ranunculus cymbalaria Pursh.
33	Parnassia kotzebui C. & S.
76	Chrysosplenium tetrandrum Th. Fries.
34	Saxifraga bracteata D. Don.
95	Saxifraga foliolosa R. Br.
89	Saxifraga hieracifolia Waldst. & Kit.
53	Saxifraga hirculis L.
88	Saxifraga punctata L. ssp. nelsoniana (D. Don) Hult.
91	Saxifraga serpyllifolia Pursh.
38	Saxifraga unalaskensis Sternb.
114	Saxifraga bronchialis L. ssp. funstonii (Small) Hult.
121	Saxifraga oppositifolia L.

APPENDIX - TABLE 8. (continued)

28	Taraxacum sibiricum Dahlst.
67	Petasites frigidus (L.) Fries.
93	Saussurea angustifolia DC.
56	Artemisia trifurcata Steph. var. heterophylla (Besa.) Kudo.
26	Artemisia arctica Less var. beringensis Hult.
97	Artemisia tilesii Ledeb.
86	Artemisia senjavinensis Bess.
23	Arnica lessingii (T. & G.) Greene
44	Senecio atropurpureus tomentosus (Kjellm.) Hult.
3	Senecio pseudo-arnica Less.
35	Antennaria monocephala DC.
20	Salix crassijulis x ovalifolia Flod.
21	Salix reticulata L.
129	Salix ovalifolia Trautv.
24	Salix rotundifolia Trautv.
63	Salix arbutifolia Pall.
133	Salix arbutifolia x ovalifolia Hult.

LICHENS (Identified by H. Krog)

1.	Cladonia alpestris (L.) Rabh.
2.	Sphaerophorus globosus (Huds.) Vain
3.	Thamnolia vermicularis (Sw.) Ach.
4.	Cetraria cucullata (Bull.) Ach.
5.	Cetraria islandica (L.) Ach.
6.	Lobaria linita (Ach.) Rabh.
7.	Nephroma expallidum Nyl.
8.	Dactylina arctica
10.	Cladonia coccifera var. pleurota (Flk.) Schaer
11.	Alectonia nigricaus (Ach.) Nyl.

APPENDIX - TABLE 9. BIRDS, MAMMALS AND FISHES OBSERVED AT ST. MATTHEW IS. 1957

BIRDS

Date First Observed	Species	Total Number Seen 7/15 - 8/9
7/15	McKay's snowbunting	115 (nesting)
7/15	Rosy finch	27 (nesting?)
7/15	Kittiwake	1,200 (nesting)
7/16	Bairds cormorant	375 (nesting)
7/16	Glaucous gull	70
7/16	Tufted puffin	450 (nesting)
7/16	California murre	1,300 (nesting)
7/16	Pacific eider	220 (nesting)
7/16	Ruddy turnstone	90
7/16	Pigeon guillemot	400 (nesting)
7/16	Northern phalarope	35
7/16	Red-backed sandpiper	350 (nesting)
7/16	Alaska longspur	45 (nesting)
7/17	Little brown crane	14
7/17	Whistler swan	2
7/17	Pintail duck	15 (nesting)
7/17	Aleutian sandpiper	110 (nesting)
7/18	Old squaw duck	40 (nesting)
7/18	Redpoll	15 (nesting)
7/18	Horned puffin	550 (nesting)
7/21	Red-throated loon	12 (nesting?)
7/26	Parasitic jaeger	2
7/26	Paroquet auklet	350 (nesting)
7/29	Wandering tattler	5
7/26	Pacific fulmar	100 (nesting)
7/15	Black-footed albatross	2 (offshore)
7/29	Least sandpiper	5
8/9	Harlequin duck	20

Frank Beals, FWS refuge manager, observed the following additional species while on the island during June 24 through August 15, 1944 (Beals, 1944):

Red-breasted merganser	common
Long-tailed jaeger	abundant
Snowy owl	abundant
Least auklet	rare
Northern loon	rare
Golden plover	rare
Pelagic cormorant	common

The many jaegers and owls seen in 1944 were apparently attracted by the high population of voles that was present on the island at the time.

MAMMALS

Meadow vole - Microtus abbreviatus:

Evidence of previous abundance of the meadow vole, in the form of abandoned runways, was common throughout the island. The 1957 population was very low; over a hundred trap nights of effort failed to secure a specimen. A few fresh runways were seen at the north end of St. Matthew Island and on Hall Island. Reports by other observers indicate that the vole population is subject to extreme fluctuations. Hanna commented on the low numbers of voles in 1916 and Beals and Rausch reported population highs in 1944 and 1954.

Arctic fox - Alopex lagopus:

Foxes were abundant on the island in 1957. Rausch reported them to be uncommon in 1955 while Beals, in 1944, listed them as common but not abundant. Hanna's 1916 observations mentioned fox, or evidence of them, present at every landing they made. Two skulls and one skin collected during 1957 have been deposited in the University of Alaska collection.

Polar bear - Thalarctos maritimus:

No recent evidence of polar bears was found. The old, well-worn polar bear trails mentioned by early observers were still plainly visible on the tundra adjacent to the beaches. A few weather-eroded skulls were found throughout the island. Elliot (1880) landed on St. Matthew and Hall Island in 1874 and reported polar bears very common, estimating 250 to 300 present on the two islands. Hide hunting was common at this time and 16 bears were killed there as late as 1890 (Beals, 1944). Elliot refers to a party of five Russians and seven Aleuts who passed the winter of 1810-11 on St. Matthew Island. Four of the Russians died of scurvy. Their object was polar bear hide hunting. During the visit of the Harriman Expedition in 1899 there was no evidence of polar bears being present on the island (Merriam, 1901).

Harbor seal - Phoca vitulina:

Approximately 200 harbor seals were seen at various points around the island. The largest concentration was on an offshore rock five miles east of Sugarloaf Mountain. One harbor seal skull was collected and is in the University of Alaska collection.

Sea lion - Eumetopias jubata:

Three sea lion carcasses were found on the beaches at the north end of St. Matthew Island and a group of about 350 sea lions was seen at a rookery two miles south of Elephant Rock on Hall Island.

APPENDIX - TABLE 9. (continued)

Walrus - Odobenus rosmarus:

Four walrus carcasses were found on the beaches of the north end of St. Matthew Island. Three of these were large bulls, while the fourth was a young male. All of the carcasses appeared to have been washed up by spring storms. During an aerial flight over the island in May 1955, several walrus were observed hauled out on the ice on the northeast side (Rhode, viva voce, 1956). Walrus have been known to haul out on the northwest cape of Hall Island in past years (Hanna, 1920).

OTHER MAMMALS:

Whale remains were common on the beaches, Hanna (1920) identified remains of the bowhead, Balaena mysticetus, humpback, Megaptera novae-angliae, sulphur-bottom, Sibbaldus musculus Bairds, Berardius bairdi and the killer whale, Grampus restipinna. Gray whales, Eschrichtius glaucus were seen feeding off the northeast shore of St. Matthew Island in 1957.

A beach worn skull of a fur seal, Callorhinus ursinus, was found at the north end of St. Matthew Island. There has been no record of fur seals using these islands in past years.

No evidence of sea otters, Enhydra lutris, was found on St. Matthew Island. Kelp beds, common to the sea otter islands of the Aleutians, are absent from this area.

FISHES

Dolly varden trout, Salvelinus malma, were abundant in most of the larger drainage systems of the island, which emptied into lakes. Gravel beaches, through which the lakes drained to the sea, prevent movement of the fish to the sea, except during storms, Sticklebacks, Gasterosteus sp., were found in the brackish lagoons and pools. There is some evidence of the presence of the black fish, Dallia pectoralis, in the lakes of St. Matthew Island (Wilimovsky, viva voce, 1957).

APPENDIX - FACILITIES AND FEATURES OF ST. MATTHEW IS. OF SIGNIFICANCE IN PLANNING LAND-BASED PROJECTS.

Planning for future biological studies, or for harvest and utilization of the reindeer of St. Matthew Island, will be simplfied if information of transportation problems and existing living facilities are known.

No harbors exist at St. Matthew Island. Beach landings by boat are best made on the northeast shore during the summer months as the prevailing winds at this time are from the southwest. Airplane landings with a Grumman goose, or larger plane, could safely be made in the sea on the lee side of the island, about half of the time during mid-summer. The loose, rounded gravel of the beaches, however, would not permit taxiing a heavy plane onto the beach. None of the beaches are suitable for landings with conventional wheeled aircraft. There is a strip of old beach gravel adjacent to Big Lake, which is stabilized by vegetation and appeared solid enough to support a goose in a wheel landing. Frost conditions would effect this surface. Landings in Big Lake and two or three of the other larger lakes appear to be the most practical method of landing, or basing, an airplane at the island. These lakes are relatively shallow but with few exceptions are deep enough for safe landings. Taxiing out of the lakes could also be accomplished.

Travel over the surface of the island is most practical on foot, however, a jeep might be useful if solid routes of travel were picked out and established in advance. There are boggy areas which would be impassable. This was graphically illustrated by the presence of two, large Coast Guard Caterpillar tractors in the center of the island, which obviously became bogged down and were abandoned.

Six Quonset huts remained standing at the Coast Guard station and one at the Army weather station. All of these buildings were in poor condition but could be repaired for storage or living with a minimum of effort. Several antenna poles at the Coast Guard station could be used in setting up radio communications. Unfortunately, all of these structures are on the exposed side of the island. There is one driftwood cabin on the northeast shore near Big Lake which would be suitable summer shelter for three or four men.

Fresh water is readily available from any of the streams and most of the lakes. Driftwood, for fuel or limited structural use, is abundant on the northeast shore of the island and in isolated spots on other beaches.

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